

Lamina broadly deltoid, and, with the sporophyl, entirely bent down in veneration, sessile or nearly so.

Bud smooth, in a closed sheath, plants 5-32 cm. high, lamina 1-6 cm. long, 0.8-9 cm. broad, 1-2 or rarely 3 times divided, the sporophyl short-stalked, about one-fourth the height of the plant, the panicle usually stout and diffuse.

8. *B. lanceolatum* (Gmel.) Ångstr.

Bud hairy, in an open sheath, plants 8-80 cm. high, the lamina 2.5-35 cm. long, 4-42 cm. broad, 3-5 times divided, the sporophyl long-stalked, one-third to one-half the height of the plant, the panicle slender.

Lamina annual, panicle slender (continental North America, also in Europe and Asia).

9. *B. virginianum* (L.) Sw.

Lamina persistent for two to four years, the panicle stouter (Jamaica).

10. *B. dichronum* Underwood.

A treatment of this section of the genus *Botrychium* is hardly complete without reference to Mr. Davenport, and his contribution to our knowledge of some species in it and their relationships. His pains-taking work with *B. simplex*, and his discovery and exposition of the bud characters by which many of the species may be certainly identified, will probably always remain, from a taxonomic standpoint, the most valuable additions to our knowledge of this group.

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COLLECTING LIVERWORTS IN JAVA

BY DOUGLAS HOUGHTON CAMPELL

Two years ago it was my good fortune to spend over three months collecting in Java, perhaps the most interesting region in the world to the botanical student. Wallace pronounced Java to be the most beautiful of all tropical islands, and one who has visited it is inclined to agree with his verdict. Lying as it does only a few degrees from the equator and possessing an exceedingly heavy rainfall and a volcanic soil of extreme fertility, the vegetation shows a luxuriance and variety that far surpass anything I have ever seen in any other part of the world. This great variety is shared by the lower plants, and the liverworts include many forms of the greatest interest.

Java is extremely mountainous, being largely composed of a range of volcanoes, several of which exceed ten thousand feet in height, and there is great difference in the rainfall at various

points, the heaviest precipitation occurring in the western portion of the island where the famous Buitenzorg gardens are situated. This great range of elevation combined with the differences in rainfall results in a marvellously rich and varied flora. It is said that there are over fifteen hundred species of trees in the island, which in area is little if any larger than England.

Much of my collecting was done in the neighborhood of Buitenzorg and on the Gedeh, a mountain upon which is situated the mountain station Tjibodas, where I spent about a month.

Goebel over twenty years ago visited Java and called attention to some remarkably interesting liverworts, among which was the new genus *Treubia*, one of the largest and most striking forms known. Schiffner (Hepaticae der Flora von Buitenzorg. Erster Band. Leiden, 1900) has described the thallose forms, among which are many new species, but he has not yet published a complete list of the foliose liverworts nor of the Anthocerotites. No doubt many interesting forms will reward further explorations.

As in other tropical countries, the greatest profusion of liverworts does not occur in the hot lowlands but in the cooler and very moist mountain districts. Nevertheless, many striking species are common about Buitenzorg, whose elevation is between two and three hundred meters.

My collections were mostly confined to the thallose liverworts, as these were the ones I wished to study especially. The foliose species, however, are extremely abundant and include a great many striking and beautiful forms. Unfortunately the identification of most of these is very difficult.

The botanical garden of Buitenzorg lies but a few miles from the base of a very striking volcanic cone, the Salak, and nearly every afternoon rain clouds gather over the peaks of this landmark and a violent thunder storm sweeps over Buitenzorg, deluging everything and followed by a marked fall in temperature.

These daily drenchings cause a marvellous growth of all kinds of vegetation and liverworts luxuriate in the steamy hot atmosphere. The garden itself affords many interesting species and the densely shaded gullies and plantations everywhere are crowded with bryophytic growths. Several species of *Riccia*, *R. Treu-*

biana Steph., a large and striking species, being the most noticeable, are common on the paths and upon the ground wherever it is undisturbed, and two species of *Marchantia*, *M. geminata* Rein., Bl. & Nees and *M. emarginata* Rein., Bl. & Nees, are very abundant. Perhaps the most striking of the ground liverworts of Buitenzorg is *Dumortiera velutina* Schiffn., which is closely related to *D. trichocephala* (Hook.) Nees of the more elevated regions, and seems to take its place in the hotter lowlands. Of the thallose Jungermanniales, the most conspicuous form about Buitenzorg is *Pallavicinia indica* Schiffn., allied to the widespread *P. Lyellii*, but considered by Schiffner to be quite distinct. *Metzgeria Lindbergii* Schiffn. was not uncommon on the trunks of trees in some parts of the gardens and seems widespread through the lower elevations. A large *Riccardia* (*Aneura*), *R. viridissima* Schiffn. was also not uncommon. No collection of the leafy liverworts was made in Buitenzorg, but these are abundant upon the trees everywhere in the deep shade of plantations. Several species of *Anthoceros* are very common, growing upon the ground everywhere, but these have not yet been identified. A *Notothylas*, probably *N. javanicus* Nees, is also not rare, but no specimens of *Dendroceros* were collected about Buitenzorg. The latter, growing as it does in masses of mosses and liverworts, is difficult to find and it is not unlikely that more careful search would have brought it to light.

By far the most interesting collecting ground near Buitenzorg is the region about the foot of the Salak. Here in the dense forest and along the walls of the wild gorge of the Tjiapus there is a wonderful growth of liverworts in great variety. Of the forms quite new to me, the most conspicuous was the very striking *Cyathodium foetidissimum* Schiffn. This grows in little caverns and upon densely shaded rocks, and owing to some peculiarity of the cell-structure the light is reflected from the large chromatophores so that the plant gleams with a vivid emerald light. When handled it emits a very pungent odor like creosote, which clings to the hands tenaciously. The most interesting find was a lot of an *Anthoceros* which proved on examination to have multiple chromatophores, like a fragment which I collected some

ten years ago in Jamaica but had not found since. As this was one of the forms I was especially looking for, its discovery was the event of this interesting expedition. This has since been made the type of a new genus, *Megaceros*. Another undescribed species of the same type was found afterward in the more elevated region about Tjibodas.

Lying on the slope of the magnificent volcanic mass Gedeh, is the mountain station Tjibodas, a dependence of the great garden at Buitenzorg. Tjibodas comprises a garden where are grown many plants of temperate and subtropical regions, and includes a laboratory with living accommodations for four persons. The elevation of the garden is about fourteen hundred meters and I found the temperature almost cooler than I liked after the hot-house temperature of Buitenzorg. The thermometer seldom rises above 20° C. and as it is apt to be foggy and rainy, it is often decidedly chilly, especially in the morning and evening. But in this cool moist atmosphere liverworts revel and I have never seen anything to approach the hepatic flora of this mountain.

From the garden up to the summit of the highest peak, Pan-gerango, which is ten thousand feet high, is an unbroken primeval forest of wonderful beauty, and overflowing with botanical treasures of every description. For a long distance beyond the garden, which abuts directly upon the forest, a series of paths have been cut through the forest, and these are numbered so that one runs little danger of getting lost in the dense jungle, which without such paths would be quite impenetrable. Many of the finest trees are labeled and several thousand of them are numbered. Otherwise the forest has been untouched.

The paths in the garden and the sides of the banks were often densely overgrown with masses of *Marchantia* and *Anthoceros* of several species. Of the former the most conspicuous was *M. nitida* Lehm. & Lindenb., a large light-green species growing in extensive mats. Several others also occurred.

It was in the forest, however, that the great majority of the forms grew. I naturally was anxious to collect *Trebubia* and found that the native collector Sapihin was well acquainted with this; so very soon after my arrival at Tjibodas we started out in

quest of this interesting plant. After a walk of perhaps a couple of miles along one of the main paths skirting the edge of a deep gorge through which flowed a considerable stream, of which only now and then one caught a glimpse through the thick tangle clothing the sides of the gorge, we arrived at our destination. Every few minutes one stopped to gather some rare and beautiful plant. The sides of the path were covered with fine mosses and liverworts, the trunks smothered in mats of liverworts and ferns with all sorts of epiphytic growths among them. Flowers were not very abundant, but yet there were some that would attract the most unobservant eye. A *Gordonia*, a tree loaded with big white blossoms like Cherokee roses, was very common, and often, close to the ground, the bright red cone of a Zingiberaceous plant, an *Elettaria*, caught the eye, or the scarlet bell of an *Aeschynanthus*, an epiphytic Gesneriad, flashed like a spark in the gloom of the dense forest. Exquisite pink and white balsams were very common and now and then a handsome ground orchid was seen. A few small palms grew among the tangle of other plants and splendid tree ferns abounded on all sides. Enormous specimens of *Angiopteris*, one of the Marattiaceae, were common, and upon the trees a great variety of epiphytic ferns, *Ophioglossum pendulum*, *Asplenium Nidus*, various Hymenophyllaceae and many others contended with other plants for a foothold. With all these distractions it was not strange that we were a good while in covering the road to the spot where *Treubia* was to be found. But finally we arrived and plunged into a dense thicket, Sapihin plying the wicked-looking big knife which every Malay seems to carry, to cut through the thick sappy stems of the rank vegetation which choked our path. The *Treubia* was growing in thick mats over fallen rotten logs and on the wet ground, its big fleshy fronds a full inch across, and I soon had a fine lot of specimens in my collecting bag. Near by we also found the rare and beautiful *Calobryum Blumei* Nees, which Goebel rediscovered. This upright liverwort, with its large spirally arranged leaves, looks very much more like a big moss than it does like a liverwort, but the long stalked sporogonium is typically hepatic in aspect. Both of these species were collected repeatedly later on, and although

not common are by no means so rare as has generally been assumed.

Of the more conspicuous liverworts abounding in the immediate vicinity of the Garden, the biggest is *Dumortiera trichocephala* (Hook.) Nees, which reaches gigantic dimensions, but on account of its extreme brittleness is almost impossible to remove entire from the ground, to which it clings tenaciously. A curious fact was brought to light in regard to this species by Prof. A. Ernst, of Zürich, who was staying at Buitenzorg when I was there. He found that the receptacles are very commonly hermaphrodite. This is very easily confirmed on examination. Professor Ernst has since published an account of this fact.

Of the thallose Jungermanniales, aside from *Treubia*, several genera, *Pallavicinia*, *Metzgeria*, and *Riccardia*, are common, and the rare *Calycularia radiculosa* Steph. was also found a number of times. The genus *Riccardia* is especially abundant, including some twenty or more species. Some of these are very large, *R. maxima* Schiffn. having a thallus a centimeter or more in breadth, but other species are exceedingly minute, *e. g.*, *R. parvula* Schiffn. Of the twenty-four species of *Riccardia* given in Schiffner's list, all but four are described as new. Whether these will all hold remains to be seen. I have myself found it impossible to distinguish certainly between his *R. maxima* and *R. viridissima*, and it may be that the number of species may not be quite so great as he assumes. The commonest species of *Pallavicinia* is *P. Levieri* Schiffn., and of the two or three species of *Metzgeria* the widespread *M. hamata* Lindb. is the most abundant. Of the very numerous foliose liverworts one of the most striking was a *Schistochila*, which was not at all rare. The curious little *Zoöpsis argentea* Hook. & Taylor was also collected but was not common.

During the month spent at Tjibodas daily excursions into the forest were made, and one expedition lasting several days was made to the summit of the mountain. This was full of interest and many forms were collected which did not occur at the lower levels. Near the waterfall of Tjiburrun, specimens of *Marchantia cataractarum* Schiffn. were found, a species as yet collected

only from this mountain. The monotypic *Wiesnerella javanica* Schiffn., also known only from this immediate neighborhood, grew in large masses. This is a Marchantiaceous form evidently allied to *Dumortiera*, but having air-chambers and stomata like those of the typical Marchantiaceae. Some remarkable hot springs, Tjipanas, occur on the way up, and the hot steam has caused an extraordinary development of vegetation. Where the hot water oozed out of the hillside thick cushions of *Sphagnum* and other mosses and liverworts grew about the springs. Among the liverworts growing here was *Pallavicinia radiculosa* (Sande Lac.) Schiffn., which was some six inches or more in length. A couple of days were spent at Kandang Badak, a saddle between the two cones of the mountain. At this place, which lies at an altitude of about twenty-five hundred meters, a substantial shelter hut has been built and one can camp out very comfortably here for as long as one wishes. At the higher elevations the hepatic flora is not so well developed as further down, but mosses and lichens are more abundant. Some species of liverworts, however, are confined to this higher elevation. Of these alpine Hepaticae, the beautiful *Pallavicinia Zollingeri* Gottsche is the most striking. This is one of the section, *Mittentia*, with creeping rhizomes and upright fan-shaped dichotomously branched laminae looking like little fern leaves. This beautiful hepatic was common from a height of about twenty-two hundred meters up nearly to the summit of Pangerango, the highest of the two peaks. Pangerango is a very perfect extinct cone, and seems to have a heavier rainfall than the neighboring active crater of Gedeh. Another rare liverwort collected on Pangerango was *Fimbriaria Zollingeri* Steph.

On the return to Tjibodas, a very large and conspicuous *Dendroceros* was collected. The occurrence of this genus at such an elevation (about 2,200 meters) was quite unexpected. This probably is an undescribed species, but no authentic specimens of *D. javanicus*, the only species hitherto recorded from Java, were available for comparison. A second, much smaller species was afterward collected at Tjibodas, but which if either of these is the true *D. javanicus* remains to be seen.

While at Tjibodas further search was made for the *Anthoceros* with multiple chromatophores collected near Buitenzorg. This species was not found, but another one was discovered, much larger and not at all uncommon. This grew usually upon rotten logs but afterwards was found also upon the ground and occasionally upon boulders. It is possible that the form growing upon the boulders is distinct. This species was named *Megaceros Tjibodensis* and a full account of it as well as of the other species has been published (Some Javanese Anthocerotaceae. No. I. Annals of Botany, vol. 21. October, 1907).

A brief excursion was also made to Garoet, lying in the mountains to the southeast of Buitenzorg in a much drier district with a correspondingly poorer flora. The liverworts of this region are some of them xerophytic in character, growing upon more or less exposed rocks. At this place I found *Targionia dioica* Schiffn. and a species of *Fimbriaria* occurring in clefts among the lava blocks upon the exposed slopes of the Goentoer, a volcano in the neighborhood of Garoet. The other forms collected appeared to be the same as those found about Buitenzorg.

No account of the collecting in Java would be complete without an acknowledgment of the very great indebtedness of all botanists to the admirable organization of the botanical gardens and the allied Department of Agriculture, which is largely due to the efforts of the distinguished director, Professor Treub. Everything is done to aid the visiting botanist, all the very complete laboratories and libraries being placed freely at his disposal. The opening of the wonderful forest of Tjibodas and the help of the efficient native collectors, whose acquaintance with the native plants is very extensive, make collecting a comparatively simple and expeditious matter, and one is able in a very short time to accumulate a mass of invaluable material, which it would be impossible to duplicate elsewhere.

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